

BONE “TAXON” B: REEVALUATION OF A SUPPOSED SMALL THEROPOD DINOSAUR FROM THE MID-CRETACEOUS OF MOROCCO

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ABSTRACT

Two cervical vertebrae from the Kem Kem beds of Morocco have been referred to “Bone ‘Taxon’ B,” representing a small theropod of indeterminate affinity. Reexamination of the vertebrae indicates that they are both probably from immature individuals and cannot be reliably referred to the same taxon; neither conclusively represents a small, adult theropod dinosaur. CMN 50810 has one apomorphic character, but it can only be referred to *Saurischia incertae sedis*. CMN 50811 is reinterpreted as representing an abelisauroid theropod, possibly a noasaurid.

Introduction

The early Cenomanian Kem Kem beds of southeastern Morocco have produced a famously diverse assemblage of large-bodied theropod dinosaurs (Russell, 1996; Sereno et al., 1996; McGowan and Dyke, 2009), but smaller theropod material is comparatively poorly known. Russell (1996) briefly described two cervical vertebrae as “Bone ‘Taxon’ B,” hypothesized to represent a “small theropod” of indeterminate affinity. This material is reevaluated here.

Description

CMN 50810

CMN (Canadian Museum of Nature, formerly NMC) 50810 (Figure 1) is an axis missing the odontoid, axial intercentrum, and both postzygapophyses. The centrum is elongate (length >2.5 times height) and does not have a ventral keel. Its posterior articular surface is concave. A large, flat parapophysis is preserved on the right side. Pneumatic foramina are positioned on the anterior half of the centrum, and the foramen on the left side is split by a lamina. The interior pneumatic architecture of the centrum is camerate. The round prezygapophyses face dorsolaterally above the neural canal. A pair of tablike processes project anteriorly in front of the prezygapophyses. Pendant diapophyses and postzygodiapophyseal laminae are present. The neural spine is low and transversely narrow, without a spine table. A large spinopostzygapophyseal fossa occurs ventral to the neural spine posteriorly. There is no hyposphene.

Russell (1996:376) concluded from the closure of the neurocentral sutures that CMN 50810 represents a small-bodied theropod taxon, but Fowler et al. (2011) considered neurocentral closure to be an inconsistent and unreliable indicator of maturity in theropods. The neurocentral sutures of CMN 50810, though firmly attached, are readily discernible and thus not fully closed (Brochu, 1996). Although the anterior end of the axis is damaged,

the presence of an oval depression for the missing odontoid indicates that this element had not fused to the axis. CMN 50810 is here reinterpreted as an immature specimen representing a taxon of unknown adult size. Comparisons to published measurements of well-known theropods suggest a total body length of approximately 4 m at the time of death.

No characters were stated in the original description to justify the referral of CMN 50810 to Theropoda (Russell, 1996). Pneumatic cervical vertebrae are present in three groups of Cretaceous archosaurs: theropods, sauropods, and pterosaurs. CMN 50810 is unlikely to be a pterosaur because it has features not seen in other pterosaur axes (distinct parapophysis, pneumatic foramina of the centrum split by an accessory lamina), and lacks other features expected in a large Cretaceous pterosaur (post-exapophyses). A sauropod identity is more difficult to satisfactorily reject, in part because sauropod axes are highly variable, yet little phylogenetic pattern has been recognized in this variation (Wilson and Mohabey, 2006:477). Most of the variable characters in sauropod cervical vertebrae listed by Wilson and Mohabey (2006:Table 3) parallel those observed in theropods. The early ontogeny of the sauropod axis is also poorly understood. The elongate axial centrum of CMN 50810 resembles the condition in many sauropods, in contrast to the typically compact theropod axis (excluding coelophysids, ornithomimids and therizinosaurids). However, none of the character states observed in CMN 50810 are reported to occur exclusively in sauropods or theropods, so the most conservative referral pending further work is to *Saurischia incertae sedis*.

If CMN 50810 is a theropod, the presence of a sheet-like neural spine that projects farther anteriorly than the prezygapophyses is a character of coelophysoids and ceratosaurs (Tykoski and Rowe, 2004), while the relatively dorsal position of the prezygapophyses with respect to the neural canal is also indicative of a non-tetanuran affinity. Characters excluding CMN 50810 from Abelisauroidea include the absence of additional pairs of fossae

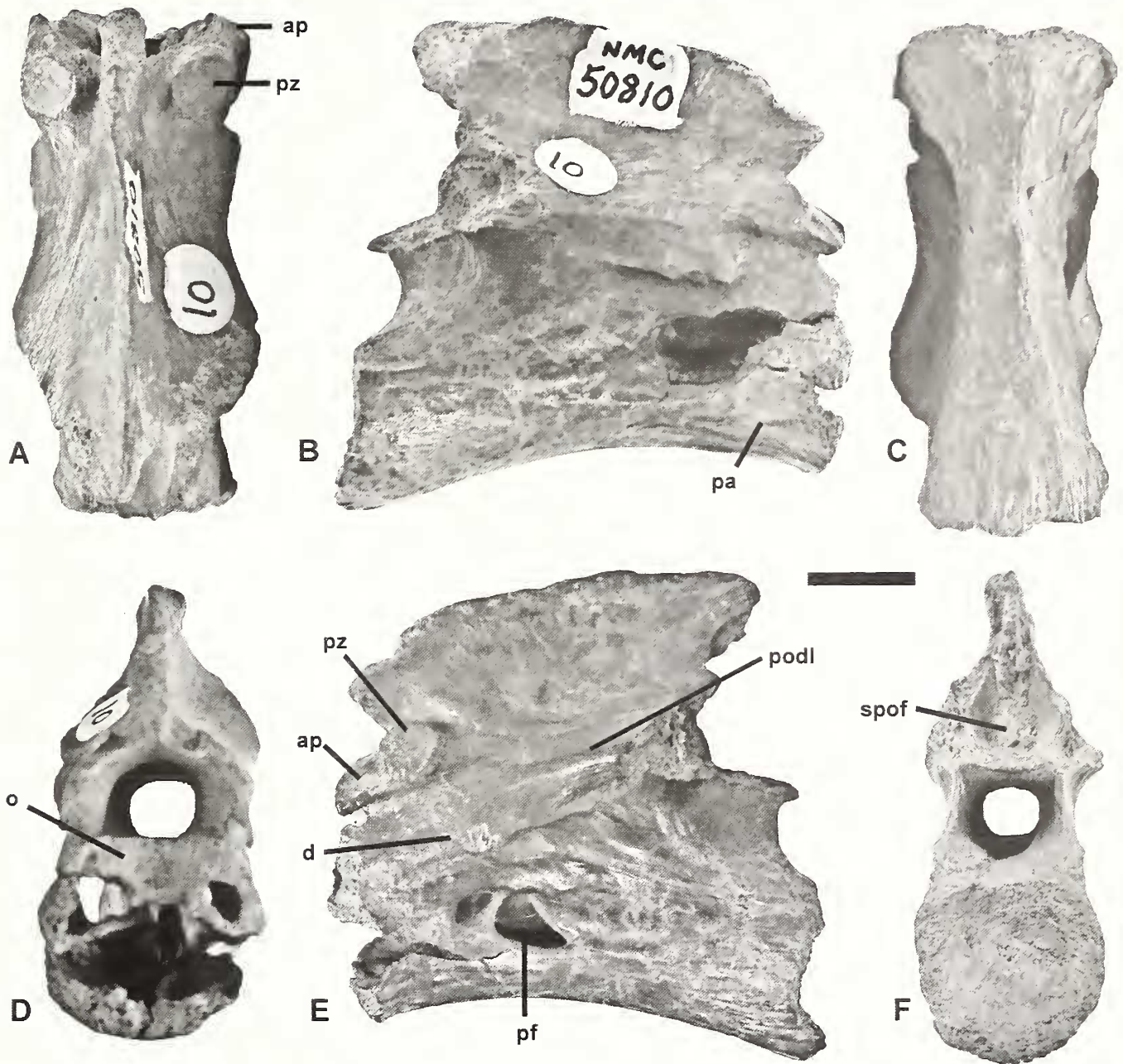


Figure 1. CMN 50810, *Saurischia* indet., axis. A, dorsal, B, right lateral, C, ventral, D, anterior, E, left lateral, and F, posterior views. Scale bar: 1 cm. Abbreviations: *ap*, tablike process anterior to prezygapophysis; *d*, diapophysis; *o*, oval depression for odontoid process; *pa*, parapophysis; *pf*, pneumatic foramen; *podl*, postzygodiapophyseal lamina; *pz*, prezygapophysis; *spof*, spinopostzygapophyseal fossa.

posteroventral to the postzygodiapophyseal laminae and posterior to the neural spine (O'Connor, 2007; Carrano et al., 2011). Elongate postaxial cervical centra are known in basal ceratosaurs (Carrano and Sampson, 2008), but no basal ceratosaur axis has been described. It is possible that CMN 50810 is a juvenile of the giant, gracile basal ceratosaur *Deltadromeus*, but this idea cannot be tested because CMN 50810 does not overlap with known material of that taxon (Sereno et al., 1996).

Regardless of the true phylogenetic position of CMN 50810, the tablike processes anterior to the prezygapophyses are an autapomorphic feature of this specimen.

CMN 50811

CMN 50811 (Figure 2) is an hourglass-shaped cervical centrum. The anterior articular surface is flat and the posterior articular surface is concave. The ventral surface is flat along the midline and lacks a keel. The pneumatic foramina of the centrum are expressed asymmetrically, with an anterior foramen present on both sides and a posterior foramen present on the left side only. The rugose neurocentral suture was completely open. No foramina are present in the neural canal.

This specimen was included in CMN (NMC) 50810 by Russell (1996:377), but there is no evidence that it represents the same

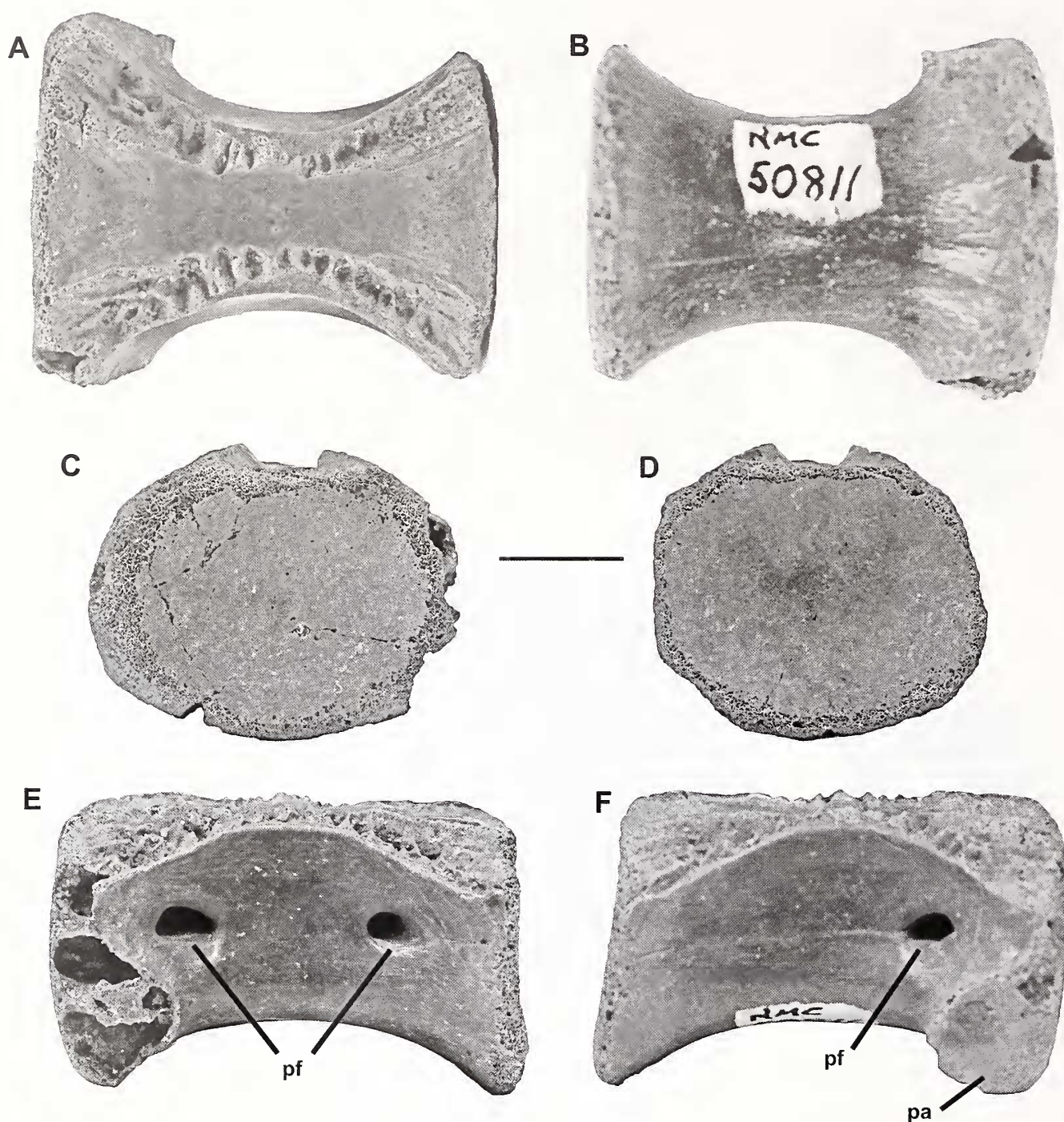


Figure 2. CMN 50811, *Abelisauroida* indet., posterior cervical centrum. A, dorsal, B, dorsal, C, anterior, D, posterior, E, left lateral, and F, right lateral views. Scale bar: 1 cm. Abbreviations as in Figure 1.

individual. The presence of separate anterior and posterior pneumatic foramina on the left side identifies CMN 50811 as a ceratosaur (Tykoski and Rowe, 2004). The overall morphology and size of the specimen is consistent with representing an individual of *Abelisauroida*, a ceratosaurian clade previously recognized in the Kem Kem beds on the basis of skull material (Russell, 1996; Mahler, 2005). Russell (1996:377) referred to CMN 50811 as belonging to the mid-cervical region, but it more closely resembles the most posterior cervical vertebrae of other abelisauroids in the completely flat anterior surface and lack of dorsoventral offset between anterior and

posterior articulations (O'Connor, 2007; Carrano et al., 2011). The modestly elongate shape of the centrum resembles noasaurids such as *Laevisuchus* (Novas et al., 2004) and *Masiakasaurus* (Carrano et al., 2011). CMN 50811 has no recognized autapomorphies, and like other described Kem Kem abelisauroid material it is here considered indeterminate at the generic level.

Discussion

The specimens originally described as "Bone 'Taxon' B" (Russell, 1996) are not supported as a single taxon, nor as

definitive evidence of a small-bodied adult theropod in the Kem Kem assemblage. The axis CMN 50810 is interpreted as autapomorphic, but likely immature (*contra* Russell, 1996), and insufficient evidence was found to conclusively decide between a theropod (basal ceratosaur) or sauropod affinity for this specimen. The centrum CMN 50811 is reinterpreted as representing a posterior cervical vertebra of a skeletally immature abelisaurid theropod, possibly a noosaurid.

Other small theropod bones described by Russell (1996) may be uncertain indicators of total body size (distal humerus, Bone "Taxon" H), or were interpreted as the immature form of a larger taxon (femur, Bone "Taxon" M). A small dorsal vertebra described as avialan by Riff et al. (2004) was considered comparable to *Rahonavis*, a taxon variously assigned to Dromaeosauridae (Turner et al., 2012) or basal Avialae (Agnolin and Novas, 2011). Rauhut et al. (2012) recently suggested that some isolated teeth referred to Dromaeosauridae, such as those described from the Kem Kem beds (Amiot et al., 2004; Richter et al., in press), may instead belong to immature individuals of large-bodied basal tetanurans. The supposed small or medium-sized Kem Kem theropod "*Kenkenia auditorei*" (Cau and Maganuco, 2009) has been recently reidentified as a crocodyli-form (Lio et al., 2012). With the reinterpretation of "Bone 'Taxon' B," it is possible that no unquestionable material of a small-bodied adult non-avian theropod has yet been described from the Kem Kem beds.

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